

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

Claim 1-3 (Canceled)

4. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device comprising:

a first semiconductor region selectively formed in a semiconductor substrate;

a second semiconductor region selectively formed in said first semiconductor region;

a trench ~~which is reached~~ extending from a major surface of said second semiconductor region to said semiconductor substrate; and

a first conductive layer ~~which is~~ formed via an insulating film in said trench; ~~wherein:~~

a gate pillar, ~~which is constituted by~~ including portions of said first conductive layer and a cap insulating film ~~for~~ capping an upper surface of said first conductive layer ~~owns a pillar which is elongated on,~~ said gate pillar projecting from a major surface of said second semiconductor region;

a side wall spacer ~~is provided~~ formed on a side wall of the ~~pillar of~~ a projecting portion of said gate pillar;

a contact hole, formed by an etching process using said side wall spacer as a mask, said contact hole extending from said major surface of said second semiconductor region toward said first semiconductor region; and

~~an electrode is connected to said second semiconductor region in a contact region which is defined by said side wall spacer; and~~

a second conductive layer, formed in said contact hole and over said semiconductor substrate, said second conductive layer being connected to an electrode; and

wherein said semiconductor substrate is ~~used as~~ a drain, said first conductive layer is ~~used as~~ a gate, and said second semiconductor region is ~~used as~~ a source.

5. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device comprising:

a first semiconductor region selectively formed in a semiconductor substrate;

a second semiconductor region selectively formed in said first semiconductor region;

~~a trench which is reached~~ extending from a major surface of said second semiconductor region into said semiconductor substrate; and

a first conductive layer ~~which is~~ formed via an insulating film in said trench; ~~wherein:~~

~~a portion of said conductive layer owns~~ a pillar, including a portion of said first conductive layer, which is elongated on said pillar projecting from the ~~[[a]]~~ major surface of said second semiconductor region;

a side wall spacer ~~is provided~~ formed on both a side wall of the said pillar ~~of said conductive layer~~ and also a side wall of a cap insulating film ~~for~~ capping an upper surface of said first conductive layer;

a contact hole, formed by an etching process using said side wall spacer as a mask, said contact hole extending from the major surface of said second semiconductor region toward said first semiconductor region; and

~~an electrode is connected to said second semiconductor region in a contact hole formed in a contact region which is defined by said side wall spacer; and~~

a second conductive layer, formed in said contact hole and over said semiconductor substrate, said second conductive layer being connected to an electrode; and

wherein said semiconductor substrate is ~~used as~~ a drain, said first conductive layer is ~~used as~~ a gate, and said second semiconductor region is ~~used as~~ a source.

6. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device as claimed in claim 4, wherein: said first conductive layer ~~which constitutes the gate is~~ includes polycrystal silicon, ~~;~~ and said insulating film ~~is~~ a includes thermal oxide film.

7. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device comprising:

a first conductivity type semiconductor main body;

a second conductivity type first semiconductor region formed at a predetermined depth within ~~one major surface of~~ said semiconductor main body, said second conductivity type being opposite to said first conductivity type;

a first conductivity type second semiconductor region formed at a predetermined depth within said first semiconductor region;

a first trench, which penetrates said first semiconductor region, ~~and is reached~~ said first trench extending from a major surface of said second semiconductor region to said semiconductor main body;

a gate pillar gate, which is constituted by both
including a gate-purpose conductive layer embedded via an
insulating film into said first trench and a cap insulating
film ~~for~~ capping an upper surface of said gate-purpose
conductive layer, and ~~a portion of which~~ said gate pillar
gate having a ~~pillar~~ portion project[[ed]]ing from the
major surface of said second semiconductor region; and

a side wall spacer formed on a side wall of the
projecting portion of said gate pillar;

a contact hole, formed by an etching process using
said side wall spacer as a mask, said contact hole
extending from said second semiconductor region into said
first semiconductor region; and

a conductive layer which is formed in said contact
hole and on a semiconductor substrate and which is
connected to a first electrode.

~~a first electrode which is electrically connected to~~
~~said second semiconductor region in a region between a side~~
~~wall spacer provided on a side wall of said pillar portion~~
~~of the pillar gate, and said side wall spacer.~~

8. (Currently Amended) ~~An insulated~~ A trench-gate
type semiconductor device comprising:

a first conductivity type semiconductor main body;

a second conductivity type first semiconductor region formed at a predetermined depth within ~~one major surface of~~ said semiconductor main body, said second conductivity type being opposite to said first conductivity type;

a first conductivity type second semiconductor region formed at a predetermined depth within said first semiconductor region;

a first plurality of first trenches which penetrates said first semiconductor region, ~~and are reached~~ extends from a major surface of said second semiconductor region into said semiconductor main body;

a conductive layer, for a gate, embedded via an insulating film into each of said first plurality of trenches, said conductive layer including a plurality of pillar portions projecting from said major surface of said second semiconductor region, each pillar portion having an upper surface capped with an insulating film; ~~and a portion of which said conductive layer for said gate owns a pillar portion projected from the major surface of said second semiconductor region~~

a plurality of side wall spacers provided formed on a respective side walls of said plurality of pillar portions and ~~also a side wall of a~~ said cap insulating films for ~~capping an upper surface of said pillar portion;~~

a second plurality of second trenches, ~~which are made shallower than said first plurality of trenches, and are formed in such a manner that said second trenches are reached extending~~ from the said major surface of the said second semiconductor region into said first semiconductor region between said side wall spacers located adjacent to each other; and

a ~~first electrode~~ source-region conductive layer, ~~which is embedded into each of said plurality of second trenches, so as to be to~~ electrically connect~~[[ed]]~~ to said first semiconductor region and said second semiconductor region to a first electrode;, and ~~which is commonly connected on said conductive layer for said gate.~~

a second electrode, for a drain, formed on a rear surface of said semiconductor main body.

9. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device as claimed in claim ~~[[7]]~~ 8, wherein:

~~said conductive layer for said gate is made of~~ includes a polycrystal silicon containing an impurity;

~~said first electrode is made of a~~ includes a first metal which contains aluminium having aluminum as a major component; and

said second electrode ~~is made of a~~ includes a second
metal material different from said first metal material ~~of~~
~~the first electrode.~~

10. (Currently Amended) ~~An insulated~~ A trench-gate
type semiconductor device as claimed in claim 7, further
comprising wherein:

a said second electrode, ~~is~~ formed on another major
surface of said semiconductor main body, ~~which is~~ located
opposite to said major surface of said semiconductor body,
~~thereof; and said second electrode is made of either~~
including a metal layer in which nickel, titanium, nickel,
and silver are sequentially stacked, ~~or another metal layer~~
~~in which titanium, nickel, and gold are sequentially~~
~~stacked.~~

11. (Currently Amended) ~~An insulated~~ A trench-gate
type semiconductor device as claimed in claim 10, wherein:
said first electrode is a source electrode; and
said second electrode is a drain electrode.

12. (Currently Amended) ~~An insulated~~ A trench-gate
type semiconductor device as claimed in claim ~~[[7]]~~ 8,
~~wherein:~~

wh rein said first plurality of trenches are formed in a stripe shape in such ~~a manner~~ that a side surface of said first semiconductor region ~~constitutes either~~ includes a crystalline surface (100) or a surface equivalent to said crystalline surface (100), and

wherein carriers are move[[d]] along either said crystalline surface (100) or said surface equivalent to said crystalline surface (100) under influence of ~~by an~~ electric field of said conductive layer ~~for said gate~~.

13. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device as claimed in claim [[7]] 8, further comprising wherein:

a field insulating film, ~~is~~ formed on a portion of the said major surface of said semiconductor main body;

an extension portion of said conductive layer, ~~for said gate is provided~~ formed on a portion of said field insulating film; and

a third electrode, ~~made of the same material as that of said first electrode is~~ connected to said extension portion of said conductive layer ~~for said gate~~.

14. (Currently Amended) ~~An insulated~~ A trench-gate type semiconductor device as claimed in claim 13, wherein:

a back-to-back protective element, ~~which is~~ electrically connected between said first electrode and said third electrode, is provided formed on another portion of said field insulating film.

Claims 15-17 (Canceled)

Claims 18-20. (Withdrawn)

21. (New) A trench-gate type semiconductor device as claimed in claim 7, further comprising:

a second electrode, formed on another major surface of said semiconductor main body, said second electrode located opposite to said major surface of said semiconductor body and said second electrode including a metal layer in which nickel, titanium, nickel, and silver are sequentially stacked.

22. (New) A trench-gate type semiconductor device, comprising:

a first conductivity type semiconductor main body;

a second conductivity type first semiconductor region formed at a predetermined depth within said semiconductor

main body, said second conductivity type being opposite to said first conductivity type;

a first conductivity type second semiconductor region formed at a predetermined depth within said first semiconductor region;

a first trench which penetrates said first semiconductor region, said first trench extending from a major surface of said second semiconductor region into said semiconductor main body;

a gate pillar, including portions of a conductive layer embedded via an insulating film into said first trench and a cap insulating film capping an upper surface of said conductive layer, said gate pillar having a portion projecting from the major surface of said second semiconductor region;

a first electrode which is electrically connected to said second semiconductor region in a region between a side wall spacer provided on a side wall of said projecting portion of said gate pillar and an adjacent side wall spacer;

a second electrode, formed on another major surface of said semiconductor main body, which is opposite to said major surface thereof; and

wherein said second electrode is made of either a metal layer in which nickel, titanium, nickel, and silver are sequentially stacked, or another metal layer in which titanium, nickel, and gold are sequentially stacked.

23. (New) The trench-gate type semiconductor device as claimed in claim 22, wherein said first electrode is a source electrode and said second electrode is a drain electrode.

24. (New) A trench-gate type semiconductor device, comprising:

a first conductivity type semiconductor main body;

a second conductivity type first semiconductor region formed at a predetermined depth within said semiconductor main body, said second conductivity type being opposite to said first conductivity type;

a first conductivity type second semiconductor region formed at a predetermined depth within said first semiconductor region;

a first trench which penetrates said first semiconductor region, said first trench extending from a major surface of said second semiconductor region into said semiconductor main body;

a gate pillar, including portions of a conductive layer embedded via an insulating film into said first trench and a cap insulating film capping an upper surface of said conductive layer, said gate pillar having a portion projecting from the major surface of said second semiconductor region;

an electrode which is electrically connected to said second semiconductor region in a region between a side wall spacer provided on a side wall of said projecting portion of said gate pillar and an adjacent side wall spacer;

a field insulating film formed on a portion of the major surface of said semiconductor main body;

an extension portion of said conductive layer for said gate provided on a portion of said field insulating film;

an additional electrode made of the same material as that of said electrode and connected to said extension portion of said conductive layer for said gate; and

a back-to-back protective element, electrically connected between said electrode and said additional electrode, said back-to-back protective element being provided on another portion of said field insulating film.